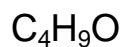
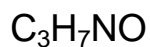
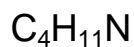


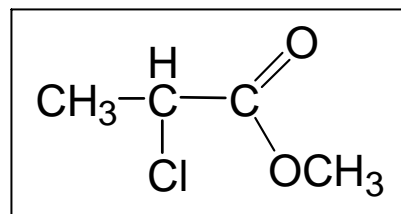
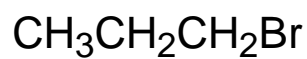
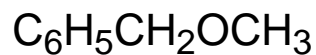
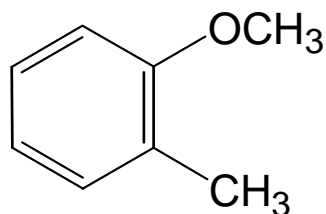
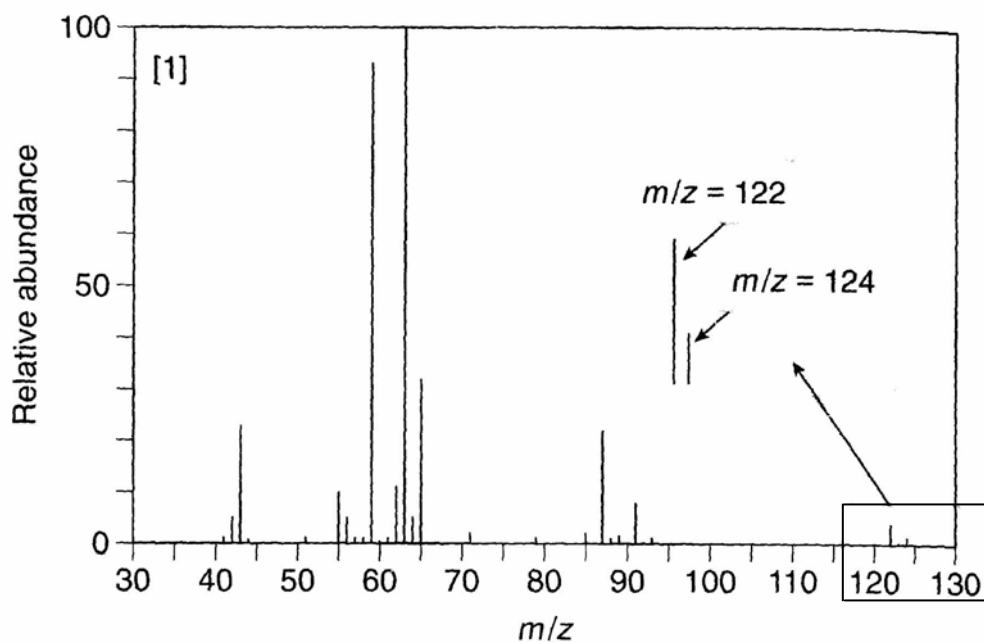
1. Multiple Choice Questions. Clearly circle your chosen answer. (30 points; 3 apiece)

a) Which formula is NOT possible for a molecular ion that has $m/z = 73$? (Problem 13.2, p 467)



All of these

b) Which compound gives the following mass spectrum? (Problem 13.21, p 486)



Name: KEY

c) Which of the following regions of the electromagnetic spectrum has the highest frequencies?

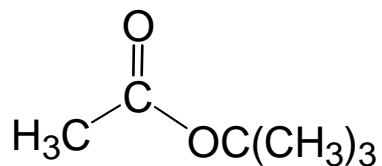
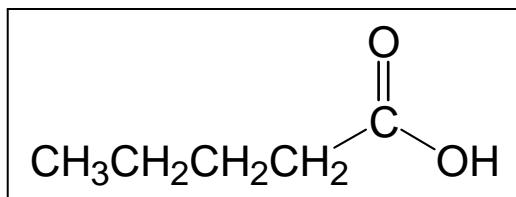
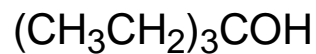
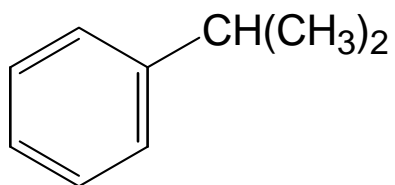
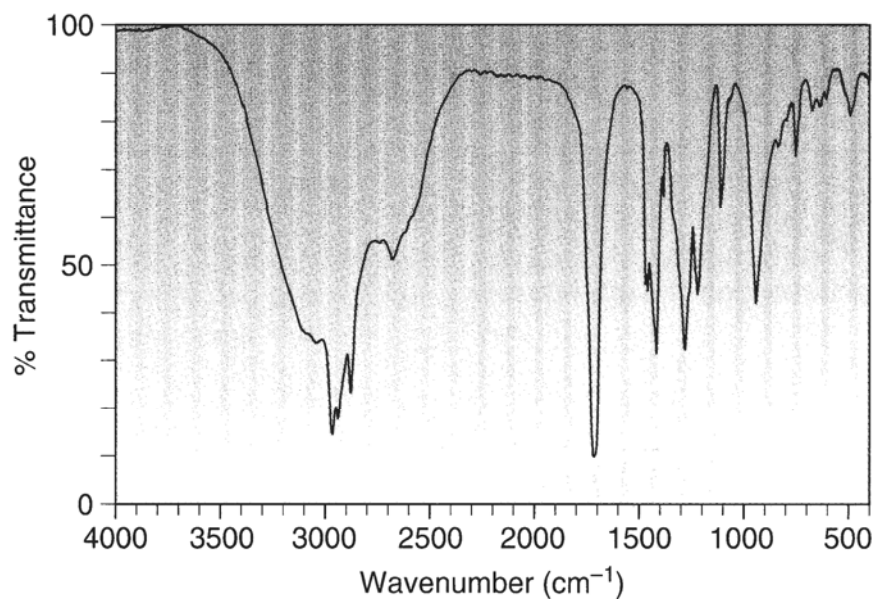
microwave

ultraviolet

visible

infrared

d) Which compound gives the following IR spectrum? (Problem 13.32, p 488)



e) How many ^1H NMR signals does the following compound give? (Problem 14.3e, p 497)



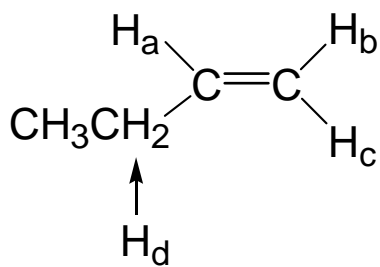
2

3

4

5

f) In the following molecule, which coupling constant is largest?



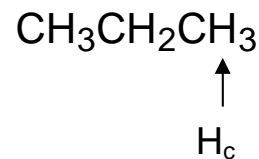
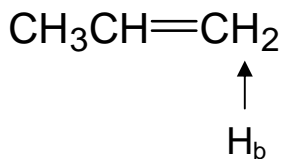
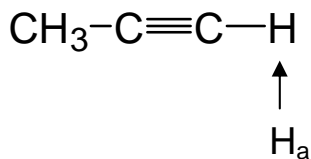
J_{ad}

J_{ac}

J_{ab}

J_{bc}

g) Rank the indicated protons in the following molecules in order of increasing chemical shift? (Problem 14.11a, p 504)



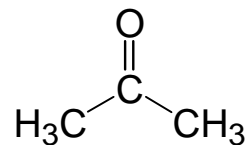
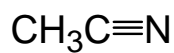
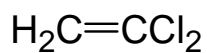
$\text{H}_c < \text{H}_a < \text{H}_b$

$\text{H}_a < \text{H}_b < \text{H}_c$

$\text{H}_c < \text{H}_b < \text{H}_a$

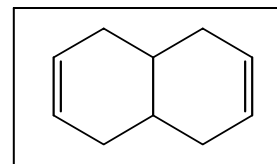
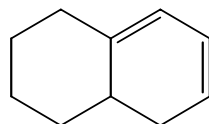
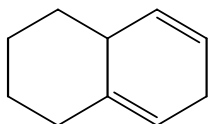
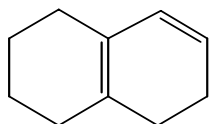
$\text{H}_b < \text{H}_a < \text{H}_c$

h) Which compound shows a sharp and strong absorption in the IR at 3300 cm^{-1} ?

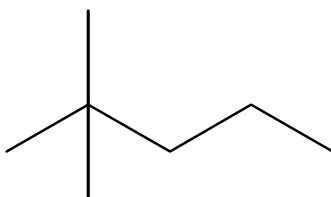


Name: KEY

i) Which compound has the highest heat of hydrogenation? (Problem 16.39, p 600)



j) How many ^{13}C NMR signals does the following compound give? (Problem 14.57b, p 533)



4

5

6

7

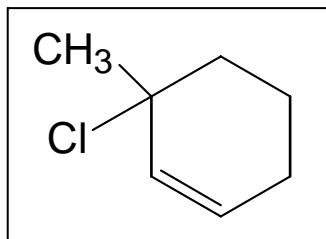
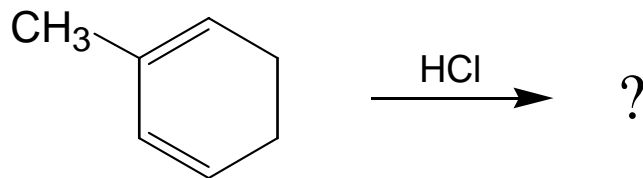
2. Comparison Questions. Clearly circle your chosen answer. (12 points; 2 apiece)

a) Which of the indicated bonds absorbs at higher wavenumber in the IR? (Problem 13.10, p 477)

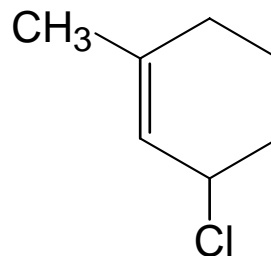
CH₃-H

CH₃-D

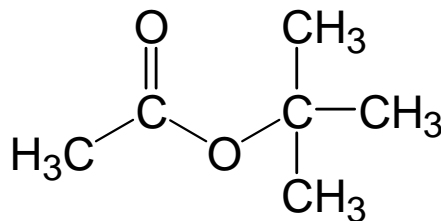
b) Which is the kinetic product of the following reaction? (Problem 16.17, p 587)



Or



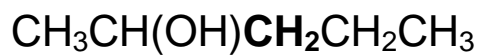
c) How many lines are observed in the ^{13}C NMR spectrum of the following compound? (Problem 14.6b, p 521)



2

4

d) Which characterizes the two protons on the **bolded** methylene? (Problem 14.7c, p 499)

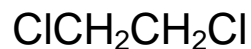
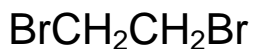


Diastereotopic

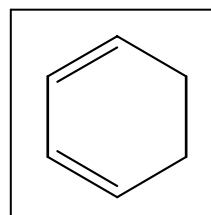
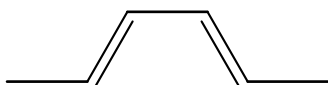
Enantiotopic

Name: ___KEY___

- e) Which compound gives three molecular ions in its mass spectrum at M , $M + 2$ and $M + 4$ in a 1:2:1 ratio?

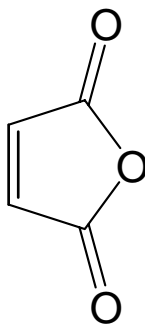


- f) Which diene is more reactive in Diels-Alder reactions?

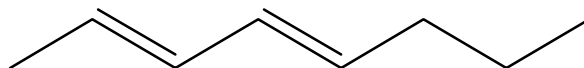


3. Draw structures of the following compounds. (8 points; 4 apiece)

- a) maleic anhydride

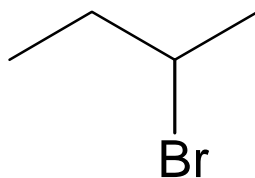
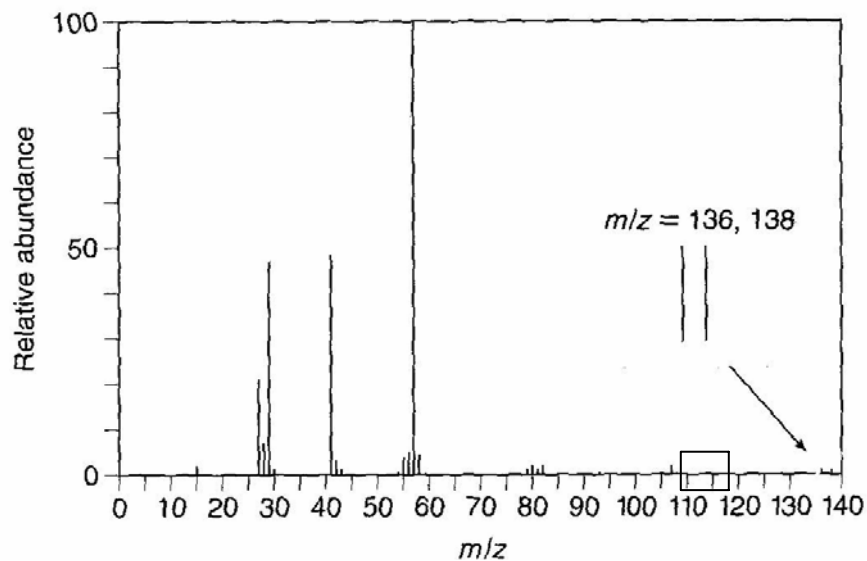


- b) (2*E*,4*E*)-2,4-octadiene in the *s*-trans conformation (Problem 16.10a, p 579)



4. Structures from Spectroscopic Data (30 points; 5 apiece)

- a) A chiral compound has a strong IR absorption at $2970\text{-}2840\text{ cm}^{-1}$ and the following mass spectrum. What is the structure of the compound? (Problem 13.36, p 489)

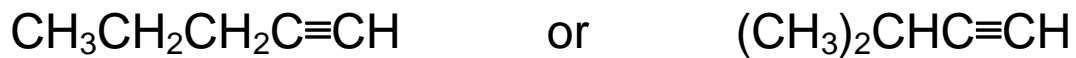


- b) What is the structure of a compound that has a molecular ion at 55, an absorption at 2250 cm^{-1} , and sp^3 hybridized CH absorption in the IR? There are no other major IR absorptions above 1500 cm^{-1} . (Problem 13.34b, p 489)

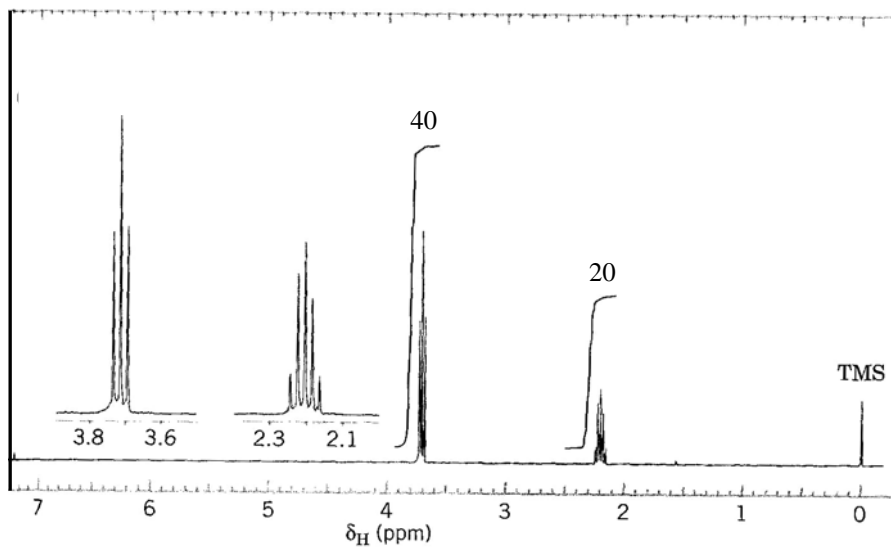


Name: KEY

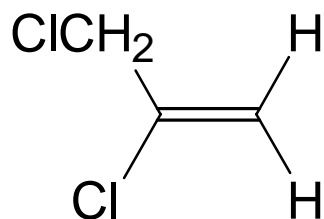
- c) A hydrocarbon has a molecular ion at $m/z = 68$ and IR absorptions at 3310, 3000-2850, and 2120 cm^{-1} . Provide a structure for this compound. (Problem 13.16a, p 485)



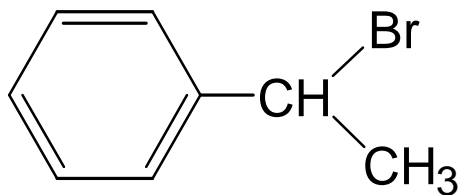
- d) Propose a structure for a compound whose formula is $\text{C}_3\text{H}_6\text{Cl}_2$ and that gives the following ^1H NMR spectrum.



- e) A compound (formula $C_3H_4Cl_2$) gives the following NMR data: $\delta = 4.16$ ppm (singlet, 2H); $\delta = 5.42$ ppm (doublet, 1H, $J = 1.9$ Hz); $\delta = 5.59$ ppm (doublet, 1H, $J = 1.9$ Hz). What is the structure of **D**? (Problem 14.21, p 515)



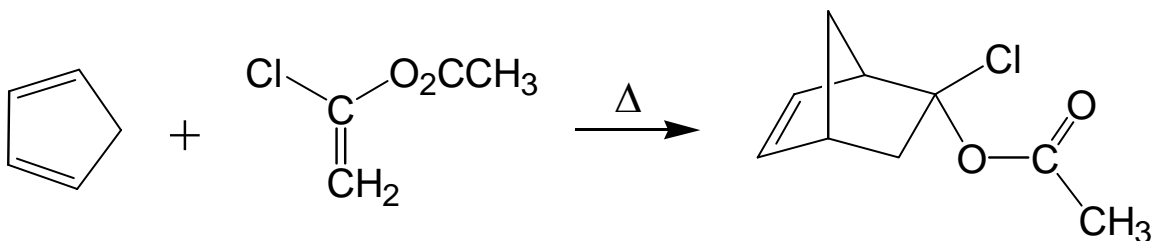
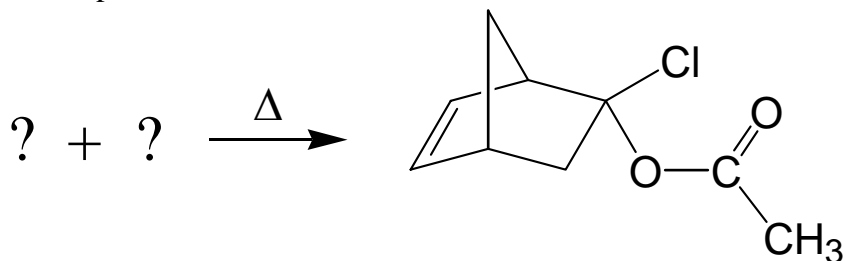
- f) A compound whose formula is C_8H_9Br gives the following 1H NMR data: $\delta = 2.0$ ppm (doublet, 3H); $\delta = 5.15$ ppm (quartet, 1H); $\delta = 7.35$ ppm (multiplet, 5H). What is the structure of the compound?



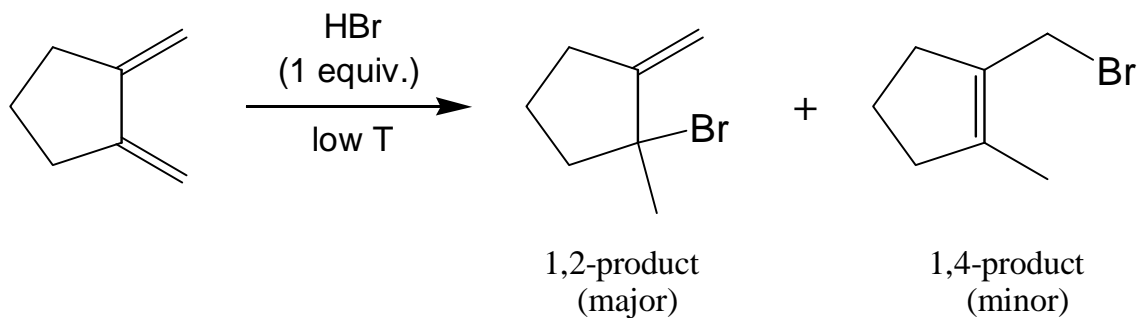
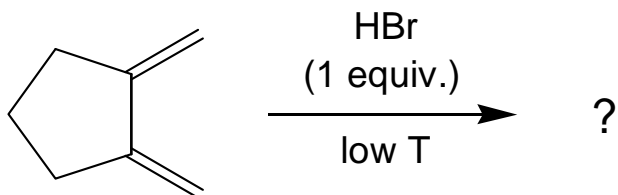
Name: KEY

5. Provide the missing products or reactants for the following reactions. If more than one product is formed, indicate which is the major and which the minor product. If there is no reaction, so indicate. (12 points; 4 apiece)

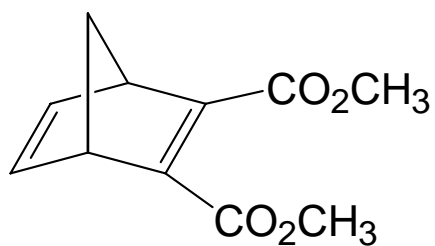
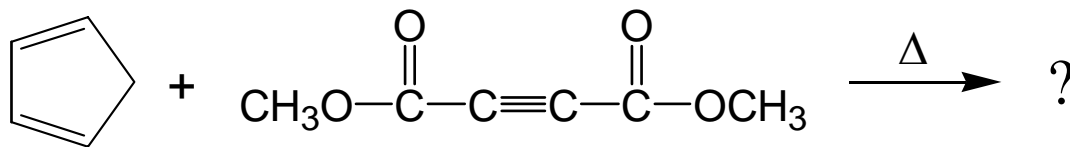
a) Problem 16.48e, p 601



b)



c) Problem 16.50b, p 602



6. Draw an electron-pushing mechanism for the following reaction. (Problem 16.16; 8 points)

